Benefits of steel solutions in bridge design
For two-span road bridges with an average span and traditional abutments, the construction of the abutment accounts for approximately 40% of total manufacturing costs of the bridge if no temporary pit walls are required. This figure rises up to roughly 55% when temporary retaining walls are required for the construction [2]. In these situations, abutments with sheet piles are a smart alternative to traditional construction, as the sheet pile can take over both functions, serve as retaining walls and as permanent, load-bearing structural elements [3].

Steel sheet piles are always highly cost-effective whenever the construction of the structure requires additional temporary pit walls. This is the case, when a change of ground level is to be accommodated during the construction stage, when building below the groundwater table and when the excavation pit needs to be protected against flooding.

Further the use of steel sheet pile abutments instead of abutments with temporary buildings pit walls can reduce total construction time by a minimum of 10% [5].

There are also significant advantages when building the composite bridge deck on hot-rolled, high strength steel sections. To reduce the space needed for the construction site, these composite elements can be partially prefabricated offsite and supplied to the construction site as load bearing elements during construction and the final stages. In addition, it is possible to install the prefabricated bridge girders during brief shut down periods of the crossed road, avoiding major disturbances to drivers and commuters, allowing traffic to circulate below the bridge while any subsequent work is safely carried out above the carriageway.

Approximately 80% of the bridges that comprise the European road network can be classified as small or medium span structures of less than 50 m. When performing a very simple analysis, reinforced concrete and prestressed concrete appear to be the most cost-efficient solutions available. On the other hand, it is widely accepted among the construction industry that composite structures are the best solution, either for spans larger than 50 m, or when height restrictions apply, or if shorter construction periods are required [1]. In recent years, numerous studies and examples have demonstrated that composite bridges provide cost effective solutions for shorter span structures even if these conditions do not apply.
A case study, performed by the Karlsruhe Institute of Technology (KIT), assesses all associated costs and performance of a traditional concrete bridge versus a bridge whose abutments are constructed using steel sheet pile sections. This comparison is performed for a two-span superstructure with spans of 22.50 m and a superstructure width of 11.50 m accounting for a standard crossing of a national road over a 3-lane motorway with an average daily traffic (ADT) of 70'000 vehicles:

Option 1: Steel Sheet Pile abutment (SSP abutment)
- 16 m long piles on the front wall;
- 13 m long piles on the lateral wings.

Option 2: Reinforced concrete abutment (RC abutment)
- 4 piles per abutment plus 2 per wing wall;
- 10 m length concrete piles of 90 cm diameter.

Choosing a bridge designed with steel sheet pile abutments and a composite deck built with steel sections leads to global cost benefits such as:
- 7% reduction on the construction costs;
- 3.5% reduction on the life cycle costs over 100 years life time (based on a real discount rate of 2%);
- Up to 15% reduction in the economic impact of the external effects during the service life of the structure.

Composite steel bridges with steel sheet pile abutments are robust structures that require limited maintenance and repairs. Due to the use of state of the art corrosion protection techniques 100-years design life without the need to replace any component are achieved.

Steel sections offer the advantage of an easy dismantling, recovery and recycling after the bridge service life, ensuring that no residues remain in the soil and adding a valuable contribution to the circular economy. This helps to prevent the abuse of natural resources.

Our steel builds bridges

Hot-rolled sections and sheet piles produced by ArcelorMittal: Our contribution to pioneering projects.

Dive into a unique video experience:
Discover the advantages of our bridge solutions in 3D-Virtual Reality